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ENGINEERING MODIFICATIONS TO CANMET TEST OVENS AND RELATED PILOT PLANT FACILITIES:

PART I: REPAIR OF OTTAWA TEST OVENS

(Project No. 3.1.2.1.03)

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JULY 1979

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Energy Research Program
Energy Research Laboratories
Report ERP/ERL 79-47 (TR)

ENGINEERING MODIFICATIONS TO CANMET TEST OVENS AND RELATED PILOT PLANT FACILITIES

Part I: Repair of Ottawa Test Ovens

by

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INTRODUCTION

The main function of the Coal Resource and Processing Laboratory (CRPL) is to qualify Canadian coal resources for use in the domestic and export markets. In the evaluation of coals for cokemaking in conventional slot-type ovens, it is mandatory that a coal or coal blend be carbonized in technical-scale coke ovens for realistic predictions of their performance in commercial practice.

The technical-scale coke ovens of the CRPL have served CANMET by assisting the Canadian coal industry in the evaluation of coking coals for use in the export and domestic markets, by resolving industrial problems in cokemaking as they occur from time to time within the Canadian steel industry, and by conducting co-operative research and development with industry through the Canadian Carbonization Research Association (CCRA).

It is essential that technical-scale coke ovens be properly maintained for optimum operating performance. In addition, new oven designs, modifications and innovations to existing ovens are necessary to keep abreast with advances in cokemaking technology. This important function is performed by the engineering staff of the Laboratory, comprising at present of an engineer and a technician who report directly to the Manager. It is hoped that this engineering nucleus will expand so as to adequately service all the various activities of the Laboratory, in the Energy and Mineral Research Programs.

The present report attempts to summarize the major changes to CANMET ovens by CRPL engineering staff during the preceding year.

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MOVABLE - WALL OVEN NO. 18 - 70

The oven was originally constructed in 1970 from engineering drawings supplied by the Homer Research Laboratories of Bethlehem Steel Corporation, Allentown, Pennsylvania. The unit was known as the horse-shoe type oven because of its unique design which incorporated the roof and both doors as a monolithic component of the oven. The component was removed vertically by a crane for discharging of the coke from the oven. There were several horse-shoe type ovens built in the United States e.g. Consolidation Coal Company, Island Creek Coal Company, Youngstown Sheet and Tube Company. The CANMET oven was initially constructed using Silicon Carbide brick for the heating chamber walls. All other horse-shoe type ovens used Silica brick walls. Subsequently oven 18-70 underwent several major changes. The horse-shoe was replaced with a fixed roof and seperate doors. The roof was cast of Durolite 24 in three seperate sections. The Silicon Carbide bricks were replaced with Silica bricks. These bricks were donated by Algoma Steel Corporation which is a CCRA member. The high density bricks were manufactured in Japan and are identical to those in Algoma's new battery of ovens.

In September 1978 the oven was shut down for about a week, as the bottom tie rods showed consistantly higher pressure distribution than the top tie rods. Unequal pressure distribution was attributed to coke pieces trapped between the movable wall and oven sole. The situation was corrected by cooling the oven to room temperature, moving apart the movable wall and removal of any trapped coke.

In January 1979, major repair work on the oven was initiated as the roof had cracked and raw gas was observed to be leaking excessively at several locations, as shown in Figure 1. The oven was shut down for two weeks, and during this period the following repair jobs were conducted:

a) The central piece of the oven roof was replaced by a new piece, which was cast from Durolite 24 and is shown in Figure 2.

b) The charging pipe was taken out, the oxidized and burnt out bottom part of the pipe was removed and a new piece welded to it.

c) The portion of the side walls under the roof was

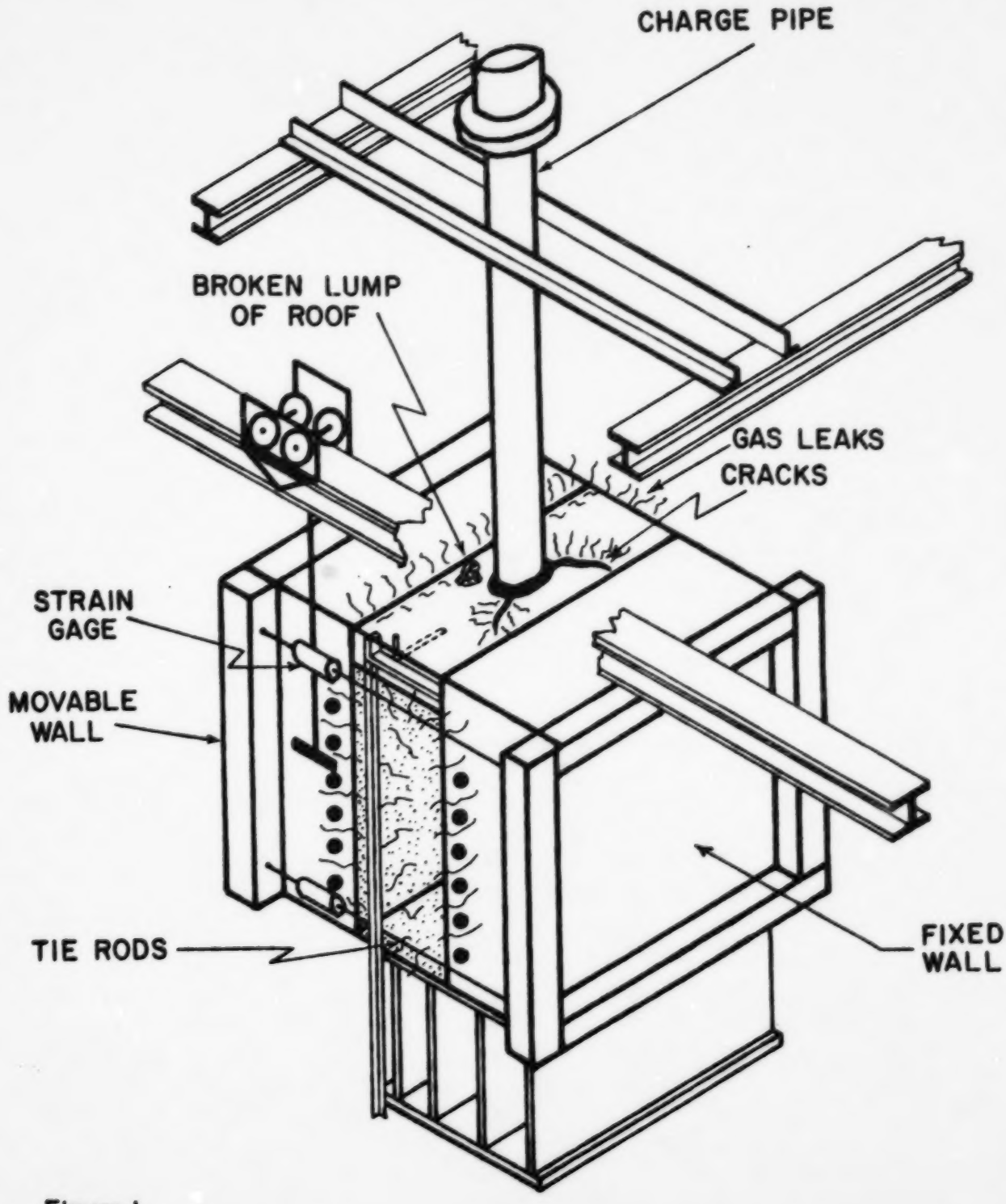

Figure I.
LEAKING SITES AS OBSERVED BEFORE OVEN REPAIR (18-70)

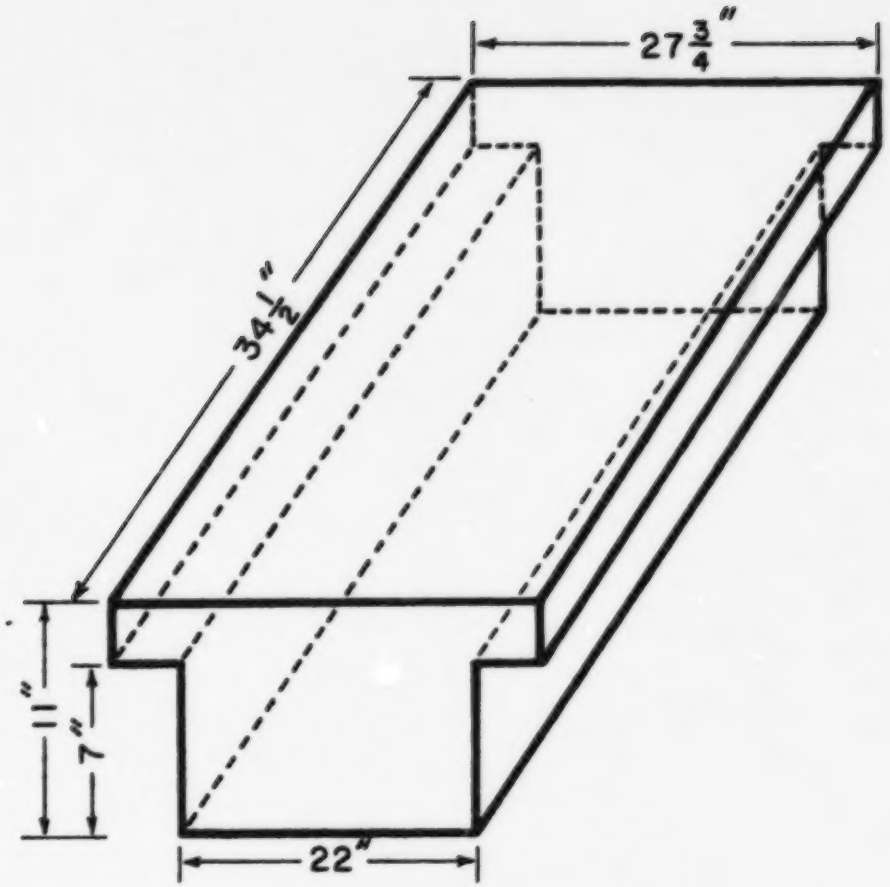

Figure 2. Centre piece out of the three blocks forming the oven roof. (18-70)

cleaned using a vacuum cleaner, i.e. removal of spent insulation - fiberfrax followed by vacuum cleaning. New fiberfrax was installed by filling the space with layers precut to the exact dimensions of the area prone to leakage.

d) The three roof pieces were placed in position using an electric hoist. The coke and push side pieces were lowered first and then the centre piece was lowered, slowly to fit in properly. Layers of fiberfrax were also introduced between each piece.

e) The charge pipe was fixed in position by aligning it with the hole in the centre piece of the roof. A thick padding of fiberfrax was placed under the flange of the charge pipe as shown in Figure 3. The weight of the charge pipe was supported on the I-beam truss structure through two $2\frac{1}{2}$" x $2\frac{1}{2}$" x $\frac{1}{4}$" angle irons, which were welded to the charge pipe, and bolted to the I-beam structure.

f) Erosion of the oven walls near the coke and push side doors was repaired using a mortar binder "Kyanex", supplied by Canadian Refractories Ltd. These areas are damaged due to movement of the doors during discharging operations.

g) Attempts were made to fix thermocouples on the Silica brick walls and the sole. However, due to lack of time and the non-availability of a fast setting binder, it was not possible to fix the thermocouples on to the wall and sole.

h) A single layer of 1" thick fiberfrax was placed in-between the oven roof and the movable wall at the point of contact. The wall was then allowed to close so as to fill up any gaps causing leakage of gas. This site is a frequent source of leakage and search for a suitable patching material is being done.

With these repairs completed the oven operation was observed over a period of several days. It was found that gas leakage was minimal,

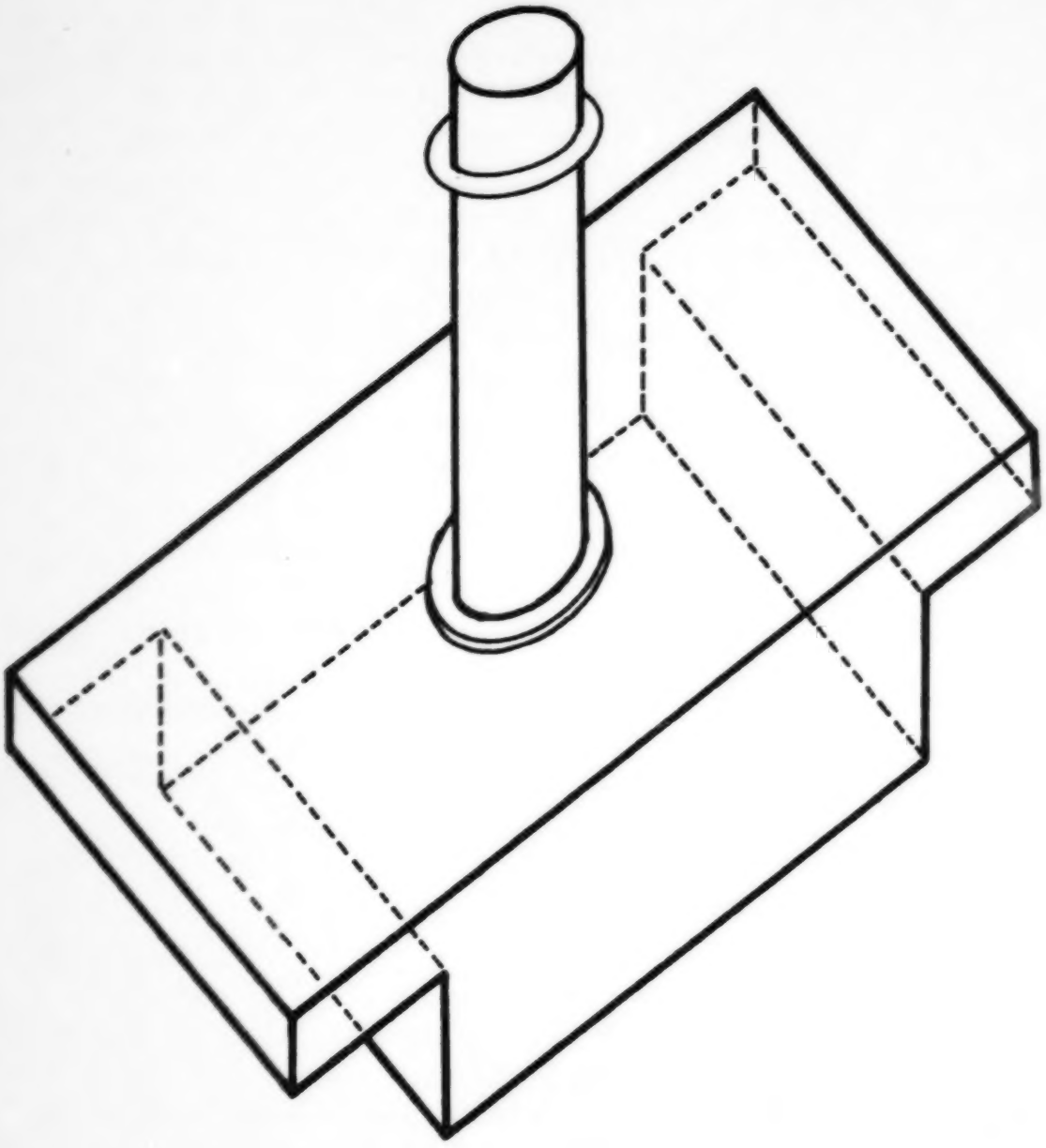

Figure 3. The charge gas off-take pipe fixed in position to stop gas leakage.

the oven responded fairly quickly to changes in temperature and pressure and that carbon build up in the gas off take pipe was very low.

MOVABLE - WALL OVEN NO. 12 - 71

The oven was built from working drawings supplied by Eastern Gas and Fuel Associates of Boston. The original oven (12-61) operated continuously at the Booth Street location of the Fuels Research Centre from 1961 until 1971 when the laboratory was relocated at the Bells Corners Complex. Oven 12-61 was replaced by oven 12-71 with major design changes, mainly the elimination of the hinged doors and the elevation of the hearth as given in Figure 4.

Some of the routine maintenance work on this oven, in the past year was re-casting new doors from Durolite 24, repairing the gas off-take/charge pipe at burnt out portions and re-surfacing the push and coke ends of the oven slot, damaged due to hammering action of the doors after each run. Another important maintenance job required replacement of burnt out insulation on the cables which carry current to globars. The insulation was burnt due to flames and intense heat resulting from blocked off take.

Major repair work on this oven was done in February 1979 after a period of approximately 3 years. During a 3-week shut-down period the following jobs were completed:

a) The oven sole which had cracked at several places was removed by gentle hammering action so as to carefully remove the cast-refractory material without breaking the layer of firebrick below it.
b) The surface of the sole was vacuum cleaned. Durolite 24 was cast over firebrick to form a new sole.
c) The oven width which had increased to more than 14" was reduced to about 12".
d) The oven roof which was anchored to the walls and partly supported by the truss structure from the top, was removed by hammering action, without breaking the wall brickwork.

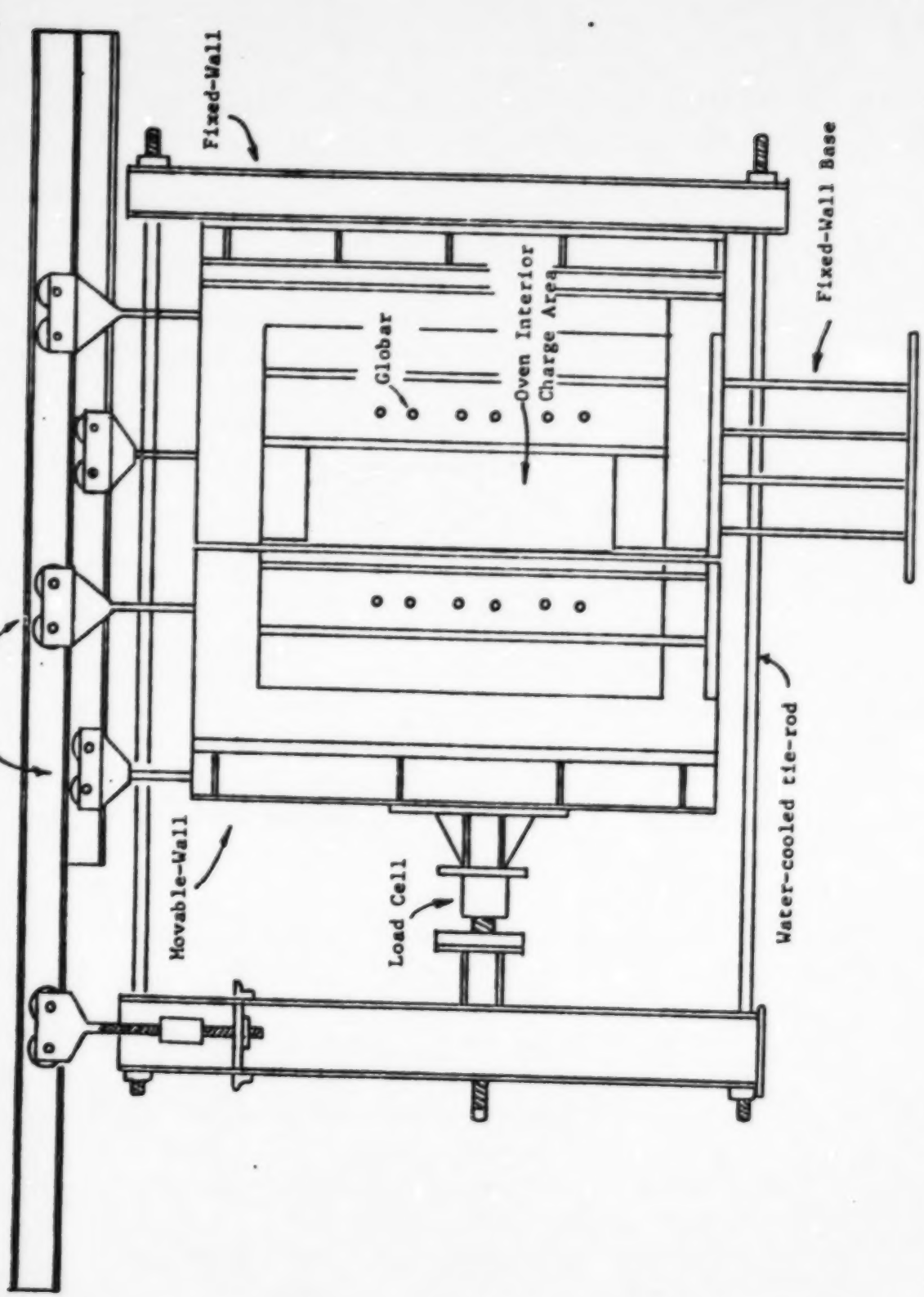

FIGURE 4 - Mines Branch Movable-Wall Coke Oven (12-71)

e) Silicon Carbide tiles were removed since they had major cracks at several places. The brickwork behind the tiles was carefully kept intact.

f) The top and sides of the oven walls were vacuum cleaned thoroughly. New tiles (Shapes EB-66,EB-67) of the dimension shown in Figure 5 were then fixed up on the walls using a cement binder (Kyanex).

g) The original gas off take pipe was discarded and a new one with larger diameter was firmly supported from the beam section. The charge pipe was similarly supported and the two placed in position.

h) The oven roof was cast in one piece with Durolite 24 and water using a concrete mixer. The steel anchors were straightened when Durolite was poured. Poured Durolite was supported on wooden framework.

i) The finishing of the oven sole was completed by putting 12" X 12" firebrick tiles on the cast Durolite.

j) Broken globars were removed and new ones placed in position.

k) Cardboard was folded around the gas off take pipe, as well as charge pipe while pouring Durolite, which was left at room temperature over the weekend to set.

The cast refractory was checked for any cracks, and the cardboard folded around the two pipes was removed after Durolite was set. The verticle stack which had been temporarily supported on the railing was brought into position over the gas off take pipe. The doors were put in position and the oven was heated slowly to the operational temperature. It was found that the oven had practically no leakage after these repairs were completed.

30 LB. OVEN

This oven has been in operation at the Energy Research Laboratories perhaps more than a decade. The origin of the oven at ERL dates back to 1958 when a survey was carried out (1) to review small and

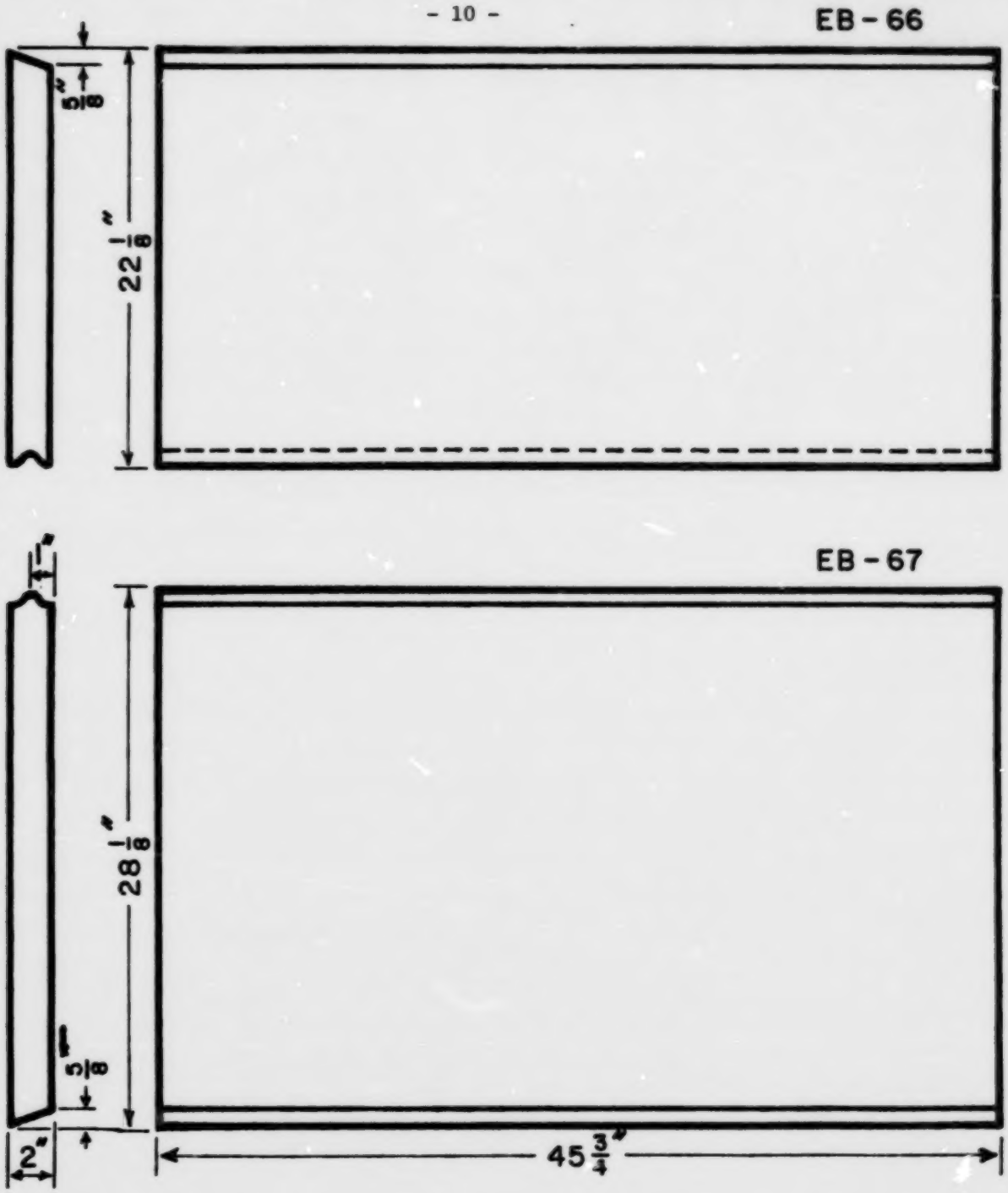

Figure 5. Silicone carbide tiles used in oven (12-71)

semi-commerical scale coke ovens for assessing the metallurgical coke making characteristics of coals. An oven with a capacity of 30 lbs. was considered to be a reasonable size based on the ovens developed by U.S. Steel (2) and BCRA (3). This decision was probably taken to use a small oven (30 lb) in conjunction with larger 12-71 and 18-70 ovens, whereby the number of confirmatory tests in larger ovens were greatly reduced, enabling rather broad surveys of coals to be made in shorter time and at a greatly reduced overall cost. A brief sketch of this oven now in operation is shown in Figure 6, and a brief oven description is given elsewhere (4,5). The oven had a major breakdown about a year and a half ago. During one of the runs the oven overheated. The overheating was so excessive that temperature in the oven exceeded melting temperature of the refractory material constituting the oven roof. This resulted in the melting of the oven roof and burning of the globars. The overheat was due to malfunctioning of the reactors.

Consequently the oven had to be rebuilt and the repair work finished, which consisted of the following:

a) The oven was completely dismantled. Burnt-out globars were replaced. The oven walls and sole was rebuilt using Silicone Carbide and firebrick tiles respectively.
b) Gold fuses were introduced into the electrical system to avoid any future cases of overheating.
c) Two new doors were cast from Durolite 24 and backed with a steel plate.
d) A new roof consisting of three pieces was cast from Durolite 24. This did not prove successful as it showed gas leakage and cracks at several locations. A single piece roof was therefore cast, which is now working without any problem.
e) New thermocouples of the type Chromel-Alumel were used to monitor the oven temperature.

CONCLUSIONS

In a research organization, which is engaged in coking studies, the importance of maintaining the Technical Scale Ovens in proper

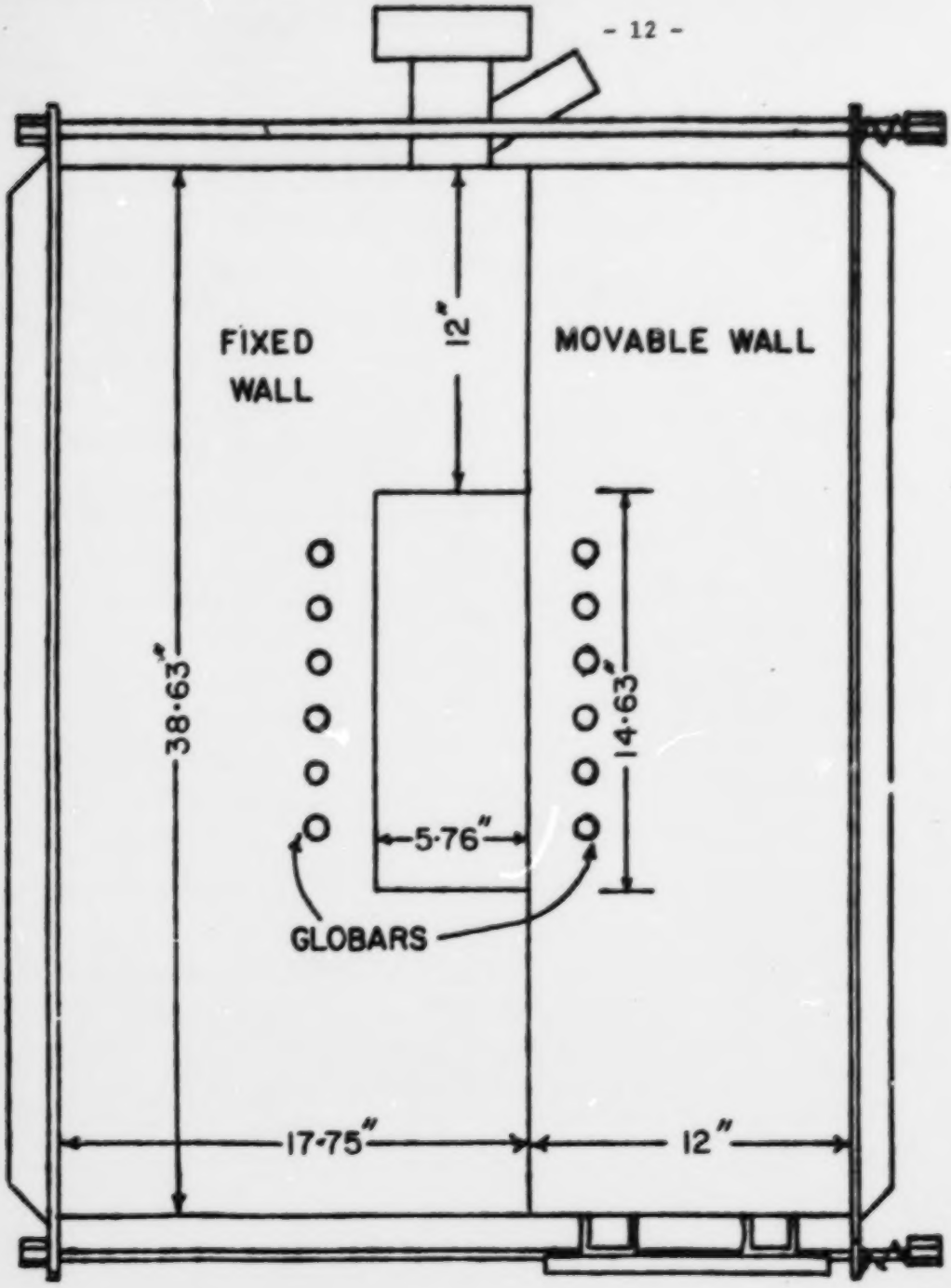

Figure 6. MINES BRANCH 30 POUND OVEN

working conditions has long been recognized. The preceeding pages illustrate some of the maintenance jobs that have to be executed within a short time to keep the ovens working. The ovens should be shutdown at least once a year for preventive maintenance.

One area of further investigation is the search for better refractory material and suitable binders to stop leaks and cracks. The existing CANMET ovens operate at temperatures of the order of 2000°F. At such high temperatures the life of the cast refractory slab is limited to two years, depending upon how well the slab, was cast. Cracks begin to appear after this period of use resulting in excessive leakage of gas necessitating oven shut-down and repair.

Another important area of maintenance is the instruments. Regular maintenance of instrumentation equipment is very important to precisely control and record the coking parameters. Routine maintenance of instruments requires changing the printing pads, cleaning or changing the nib and oiling the gears and other moving parts. Occasionally the thermocouples get burnt out and have to be replaced. These maintenance jobs though very important, do not require oven shut-down for longer periods, and so have not been discussed in this report. However, instrument calibration is done once every six months to ensure that the values recorded are representative of the conditions inside the oven.

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